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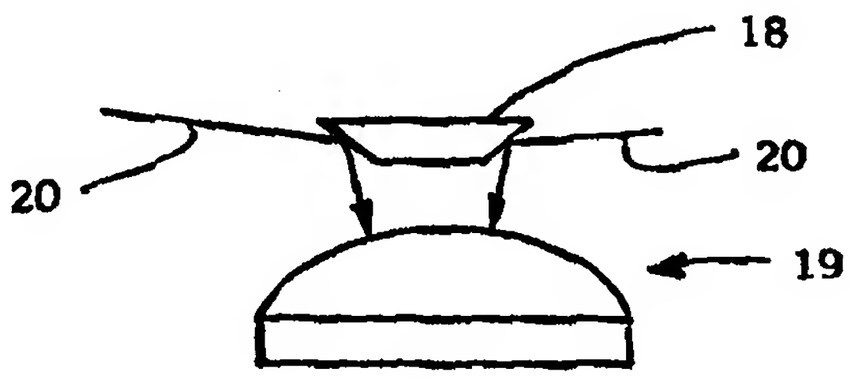
(54) Title: CAR CAM

(57) Abstract



A system which is comprised of a recording device, a triggering element, and salvage means for recent and current data. A typical application being the use of the device to document automobile accidents. This is accomplished with a recording device (1) mounted on or within a vehicle (2) or in a static position (3) so as to allow a wide view of the local environment (4) and which is or which may be of interest whereby the recording device operates continuously and records the data which describes, in video or other format, a broad field of view thereby permitting the recording device to be triggered (5) by manual and/or other means (6) so that the act of triggering salvages the recording (7) made for a period of time just prior to the triggering and for a period after said triggering (8). The purpose is initially to document those details of interest which normally escape notice and/or which are easily forgotten and which relate to the facts which indicate liability, error and/or oversight.

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CAR CAM

Field of Invention

This invention relates generally to the field of recording devices and more particularly to documentary type recording devices for commercial, engineering and scientific purposes. It also relates to the recording of information relating to infrequent events. It can document situations in order to establish the sequential facts of rare and infrequent events. In one specific appication, it can be used to document an automobile or truck accident it can document with great particularity an automobile accident and the circumstances which led to the accident. It thereby also can frequently establish legal liabilities, if any, of those involved.

The present invention permits the acquisition of data at high rates, salvaging this critical information when a specific event occurs together with the data captured just prior to the event. This is accomplished by the present invention by recording continuously on an infinite loop or a similar media and by continuously discarding all but the most recent data. The triggering event causes the recent historical data and the current data to be permanently salvaged.

One specific use of the present invention is for the documentation of automobile accidents. Such a system utilizes a pair of 360 degree optical systems, one outside on top of the roof of the vehicle and one inside of the vehicle on the bottom of the roof. These optical, video and/or eletronic inputs are recorded together as a continuous signal on an infinite loop video recorder or on an equivalent CCD computer memory. In the preferred embodiment of the system, triggering is to be realized by manual means, as a result of impact, and/or by association with an air bag system and/or a security system.

In the preferred embodiment of the present invention, the system system automatically saves 40 seconds just prior to the accident and 40 seconds after triggering. Several sets of triggering can be permitted before the permanent storage is filled. The permanent storage can be made nonerasible.

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NO PRESENTADO(A) EN EL MOMENTO DE LA PRESENTACIÓN

NON SOUMIS(E) AU MOMENT DU DÉPÔT

Summary of the Invention

A data acquisition system which is comprised of a recording device, one or more triggering means, and salvage means for recent and current data.

The system records information at the very highest possible data rates on a continuously reusable media such as a CCD computer memory or on a continuous loop video system so that the triggering event of interest salvages current information and information which just precedes the triggering event. This process therefore allows for the documentation of the critical circumstances which frequently precede serious accidents, disruptions of a production process and/or infrequent events which are otherwise difficult to document accurately.

A typical application is the use of the system to document automobile accidents. This is accomplished with a recording device mounted on and/or within a vehicle so as to allow a panoramic view of the local environment inside and outside of the vehicle while recording at the highest data rates reasonably possible. In the preferred embodiment of the system, triggering is to be realized by manual means, as a result of impact, and/or by association with an air bag system and/or a security system. The triggering act results in the salvage of both recently acquired data and current data. The system allows for accurate documentation of details of interest which normally escape notice and/or which are easily forgotten.

These and other objects an advantages of the present invention will become clear to those skilled in the art in view of the description of the best presently known mode of carrying out the intention and the applicability of the preferred embodiment as described here in and as illustrated in the several figures of the drawings.

Description of the Drawings

1. A flow diagram of a data recording system
2. A data processing flow diagram
3. A side view of an automobile
4. A side view of a truck and trailer
5. An interior side view of an automobile
6. A schematic view of a camera system
7. A schematic view of a lens system
8. A schematic view of a lens system.
9. A schematic view of a lens system
10. A flow diagram presenting the logic of a recording system
11. A flow diagram presenting the logic of a postprocessing system
12. A schematic diagram in plan view of segment views mapped, by reconstructing data, into multiple views.
13. A schematic side view of a rotating lens system and camera with mirror.
14. A schematic side view of reverse mapping using an annular lens.
15. A schematic view of a sensor/trigger device with manual trigger.
16. A schematic view of a sensor/trigger device with acclerator/deaccelerator sensing trigger.
17. A schematic view of a sensor/trigger device with security system trigger.
18. A schematic view of a sensor/trigger device with air bag system trigger.
19. A schematic view of a sensor/trigger device with deformation sensor trigger.
20. A schematic view of a radial data sweep for digital signal processing.

Specification

The present invention is a system comprised of a recording device, monitoring means, logic control means and triggering input. It permits the recording and salvage of information captured prior to the triggering event as well as data associated with an event itself. The present invention thereby permits the acquisition of the maximum possible amount of data at the time of triggering. The collection and preservation of data acquired just prior to the occurrence of an event is accomplished by recording continuously on a reusable media such as CCD computer memory or a continuous loop magnetic tape. All but the most recent data is continuously discarded. To understand the range of applications and the details of implementing the present invention, reference is made to the drawings.

Referring particularly to the figures wherein like-referenced numbers have been applied to like-parts throughout the description, Figure 1 presents a data processing flow diagram for the capture of data. Figures 2 and 11 present the processing of data in a flow diagram. In Figures 6, 7, 8, 9, 13 and 14 a typical and representative light beam path is designated by the general reference number 20. Figure 3 presents a schematic side view of an automobile 9 with a lens system designated by the general reference number 1 mounted on the top of the car 9. Figure 4 presents a schematic side view of a truck 10 and trailer 11 with a lens system 1 mounted on the top of the cab 10 and on the rear top end of the trailer 11. Figure 5 presents a schematic view of the interior of an automobile 9 with lens systems 1 mounted on the under side of the top of the roof. Figure 6 presents a schematic view of a lens system 1 utilizing reflecting mirrors 17 with a camera 19, all of which rotate about a vertical axis to give a substantially horizontal panoramic view. Figure 7 presents a schematic view of an annular lens system as a part of a lens system 1. Figure 8 presents a schematic view of a fisheye lens 14. Figure 9 presents a schematic view of a fiber optic system 2 which leads the incident light beam 20 downward to a central collecting

site, here represented by a camera 19. Figure 10 presents a flow diagram of the logic of a recording system. Figure 11 presents a flow diagram of the logic of a post processing system which produces mapped output 32, 34. Figure 12 presents a schematic plan view of the mapped output, from inside or outside a vehicle showing the radial viewing sectors 35 from a central viewing point for each of the views 36 giving a full 360 degree panoramic view in a substantially horizontal plane. Figure 13 shows a schematic view of a rotating mirror 37 as part of an optical system with a fixed or rotating camera 19. Figure 14. Shows a schematic view of a mapping procedure in which the camera 19 is logically or physically set to create a standard presentation of information representing, in time, a single visual sector 35.

Figure 15 shows a schematic view of a manual trigger system. Figure 16 shows a schematic view of a triggering system 29 using an accelerator/decelerator sensor 40. Figure 17 shows a schematic view of a triggering system 29 using a security system sensor 42. Figure 18 shows a schematic view of a triggering system 29 by using a deformation sensor 45. Figure 19 shows a schematic view of a triggering system 29 using an air bag system sensor 41.

Figure 20 presents a schematic view of a radial data sweep for digital signal processing. Given the proximity of the inner optical system, the preferred embodiment of the present invention as used with a Car Cam is to use an inner annular or conicoid 18 mirror to form a central image 48 from the optical system on the inside of the roof of the car 9 and an outer annular or conicoid mirror 18 to form a surrounding image 49 from the optical system on the top of the car 9. The sweep 47 as shown can be in either direction and can be sequentially at incrementally increasing or decreasing radii or can be in a spiral.

Table 1 presents the critical control variables for a system. In particular, the variables listed therein are T_P, in seconds, T_F, in seconds and, N_E, the maximum number of events which can be recorded. These variables determine the basic characteristics of a given system. They are the amount of time prior to an event, T_P, which will be salvaged by a triggering event; the

amount of time, T_P, during which data will be collected following triggering and the number of times the system can be triggered, N_E, which is related to the first two variables and the storage capacity of the system. The preferred embodiment of the present invention stores a maximum amount of pertinent data before, during and after an event.

Best Mode for Carrying Out Invention -- Installation in Vehicles

For automobiles, buses and trucks, the best presently known mode for carrying out the present invention is the Car Cam. With the present invention the very highest possible data acquisition rates can be used. With careful design, the data obtained can be of superb quality. Strong and compelling evidence of the facts which caused an auto accident can be obtained with this system. It utilizes a lens systems 1 inside and outside of a vehicle 9, 10, 11 and will record events on a continuous basis, even when the vehicle 9, 10, 11 is parked.

The great value of the present invention is this unique ability to document the events which precede an accident. With it, the environment in which an accident occurred and the related actions of the participants no longer needs to be established by relying upon the measurement of skid marks, wreckage and oral testimony. The negligence of participants and/or the failure of equipment, if any, which may have caused an accident thus can be shown clearly and routinely by utilizing the present invention.

With this system, substantial savings can be realized by reducing the basic uncertainty as to the important facts which caused an auto accident. The documentation of hit-and-run accidents, the avoidance of fraud and the determination of issues of fault without litigation all constitute large potential savings for the general public. The system can be produced in quantity at a commercially reasonable cost.

The preferred embodiment of the Car Cam has an optical lens system 1 which provides a 360 degree exterior view from the top of the roof of a car 9 and a 360 degree interior view from the inside of the of the car 9 centered under the roof.

As most car accidents are of short duration, a time period of 40 seconds before the triggering, T_P, and 40 seconds after triggering, T_F, should normally suffice to document the critical facts. This can be augmented by the driver by manual triggering to extend the basic recording period.

The precise type of optical system to be used can employ a wide variety of technologies. The preferred embodiment, view from both the interior and exterior view are stored as a single continuous input to a suitable recording device. This method of storage or mapping can be with conducted beams of light such as with a fisheye lens 14, with a fiber optic system 2, or with flat 17, 37 or curved mirrors 18 or with combinations of these. The use of fixed optical elements is generally preferable over a rotating system. Annular or conicoid mirrors 18 therefore are preferred and offer special advantages, as the regions directly below and directly above such a lens system 1 normally will not be of much interest. These annular or conicoid mirrors 18 have the general form of curved sections of a cone and have the advantage of allowing the efficient documentation of a full 360 degree panoramic view. In general, a fiber optic system 2 can be used to provide an equally acceptable result.

It is understood that for trucks 10 and other large vehicles, additional monitors are needed. These can conveniently be mounted on the top rear of the truck 10, trailer 11 or other large vehicle. Monitors on the side of a truck 10 can also be considered. In some instances, the point of view of the lens system 1 can be elevated by means of a stalk or extension away from the vehicle. In the preferred embodiment of the present invention, this normally is not required.

The triggering of the Car Cam system can be manual 38, 39, by reason of sensors which respond to excessive acceleration or deceleration 40, by collateral triggering from an air bag system 18 and/or by a deformation sensor 45 which responds to the deformation of an exterior body part 43 caused by a deforming force 46. The exterior body parts are typically bumpers, fenders and door panels. The triggering also can be associated with a standard car security system 41.

The compaction in data for this application is conservatively estimated at about 100,000 to 1. This is roughly based on the estimate of 4 useful years of life for a car and an average of 6 incidents over that period with 80 seconds of data per incident.

It is understood that various combinations of the foregoing monitoring means can be used to capture the incident light rays and to preserve them as is well understood with existing means such as camcorders, movie cameras, video cameras and comparable recording devices The following description of the logic used applies equally to all of the lens systems 1 shown.

Triggering and Recording Sequence

The triggering event 23 triggers the sensor/trigger 29 as shown in Figure 10 thereby signaling the computer 24 that previously recorded data 22, 25 should be saved. Upon determination by the computer 24 that this is possible, a decision is made S1 to save the old data which extends back in time for a period of T_P seconds and to salvage information S2 for T_F seconds following the triggering. The computer then checks S3 to determine if the permanent storage 22, 25 is full and if so whether to quit S4 or whether to replace or renew S5 the permanent storage 25 in which case, the computer resets S6 the sensor/trigger 29 and continues to monitor the environment. It being understood that the processing/recording device 22 and the permanent storage 25 may be the same device or may be separate devices as shown in Figure 10. When a number of events is to be stored on a single storage medium or

unit, a count, N_F, must be checked and incremented to insure that the available storage is not exceeded.

The ability to capture information which precedes a triggering event creates a look-back capability which has many advantages. The information saved relates exclusively to the event itself and therefore very high data collection rates can be utilized. Of equal importance is the avoidance of having to collect and process large quantities of information in order to obtain comparable detail.

The present invention thus efficiently documents the circumstances which precede an event as well as the event itself and subsequent developments. This ability to provide detailed documentation of unusual or dangerous situations which lead to major financial losses or to serious accidents is of critical importance. This is with regard to establishing liability and causation and as a guide to avoiding future incidents of a similar nature.

Industrial Applications

Industrial applications of the present invention include process control and quality control functions. Such a monitoring application is of particular significance when documenting infrequent events. The monitoring of continuous production activities is an excellent example of an application which would greatly benefit from use of the present invention. Generally the type of data which can be acquired spans the full range of that of concern in industrial production and control situations. Its use in the evaluation of processes and in dedicated applications in which quality control is critical. Such evaluations will benefit from the insight which can be drawn from the relatively great amount of data which can be obtained when recording infrequent and adverse events with this system.

Any generally used monitoring or sensing device which produces a signal due to a change in an environmental condition can be used to trigger the monitoring system. These

types of signals can be used in conjunction with periodic sampling approaches to data acquisition.

Scientific Applications

Scientific laboratory work and field work both can benefit from the great efficiency of this system. The documentation of many types of rare or infrequent events becomes a practical approach when using this system.

Special Applications

Applications which utilize the acquisition of data other than information from the visible spectra are also anticipated by the present invention. Data which is drawn from the ultraviolet, X-ray and infrared spectra are equally amenable to the use of this efficient monitoring system. In general, the collection of scientific, industrial and/or experimental data of a technical nature will generally benefit from the use of the present invention.

Other Applications

The present invention can be a device to record a single media or can record multimedia to include video data, audio data, pressure data, humidity data, equipment status data, dynamic production data, deformation data, earthquake data and data acquired on a periodic basis. In general the type of data acquired is unrestricted both as to variety and as to combinations of data types.

The triggering event can be manual; by setting the triggering to be a function of time, tide, sunrise or sunset; preset by computer or otherwise; by satisfying threshold boundary conditions or rates of change as to chemical and/or physical state or condition; by physical shock or impact; by electrical current or electrical charge; by rate of change such as acceleration or deceleration sensors; and by parasitic triggering based on input from another source. The triggering also can be made to occur when critical production tolerances or values are exceeded.

Post Recording Data Processing Requirements

The preferred general method of using the stored data created by the Car Cam is to create a set of 8 interior video/films 32 and 8 exterior video films 34. These are obtained by a reverse mapping 30 process which can utilize optical elements comparable to those which created the composite signal 1, 2, 17, 18, 37 or by utilization of standard digital signal processing means. In either case, in the preferred embodiment of the present invention, the end result is two sets of eight video or films 32, 34 each of which has a horizontal field of view 35 of slightly in excess of 45 degrees. Each video or film slightly overlaps the ones on either side.

Referring to Figure 20, it is understood that standard horizontal sweep systems will perform adequately and may be commercially a more reasonable approach. The radial sweep 47 approach however is probably more efficient given the manner of creation of the images 48, 49 using a Car Cam system. Other methods of digitizing and processing the data however will be superior when other than a radial system is to be used.

The post processing system can be optical, electronic or a combination of both optical and electronic. Referring to Figure 11, the permanent storage 22, 25 is shown as providing input to the optical/digital signal processing means 30 which in the preferred embodiment of the present invention having combined the interior and exterior signals, now separates these to produce two sets of 8 overlapping views 32, 34; one 34 from outside the automobile 9 form the top of the roof and one 32 from the interior from the inside top of the roof. Figure 12 shows the angle 35 covered by each viewing segment which in the preferred embodiment is slightly more than 45 degrees, the direction of viewing being shown by arrows 36. As would be obvious to one skilled in the art, the reverse mapping process can combine the inside mapping 31 the outside mapping 33 into one operation as shown in Figure 2.

This type of mapping 31, 33 into video or film 32, 34 will result in a fair amount of information which may not be of interest, however ordinary editing means 35 can be used to edit the material 32, 34 and thus to produce a short video or film 36 which presents the important information. For purposes of establishing causation and legal liability, this approach is reasonable, economical and accurate.

For data obtained from a system utilizing the present invention other than the Car Cam, the reverse mapping must be suited to the final uses to which the information will be put and upon the manner in which the initial data was created.

All of the above are only some of the examples of available embodiments of the present invention. Those skilled in the art will readily observe that numerous other modifications and alterations may be made without departing from the spirit and scope of the invention. Accordingly, the above disclosure is not intended as limiting and the appended claims are to be interpreted as encompassing the entire scope of the invention.

In the Claims

What is claimed is:

1. A recording system comprised of a reusable storage means and logic means to continually record information whereby when the system is triggered, only recently acquired information and current information is permanently saved.

2. Triggering as in Claim 1 by human action.

3. Triggering as in Claim 1 without human intervention.

4. Recorded information as in Claim 1 which is in the visual spectra.

5. Recorded information as in Claim 4 recorded by optical means and by means of a camera.

6. Information as in Claim 5 which is produced by substantially panoramic optical means.

7. Optical means as in Claim 5 comprised of mirrors.

8. Mirrors as in Claim 7 comprised of annular or conicoid mirrors.

9. Panoramic optical monitoring means as in Claim 6 comprised of light conducting means.

10. Recorded information as in Claim 1 which is not in the visual spectra.

11. A data acquisition system which acquires environmental data on a substantially continuous basis of while saving data that is currently or recently recorded when the system is triggered.

12. Environmental data as in Claim 11 comprised of date derived from areas in and near a motor vehicle or trailer.

13. Environmental data as in Claim 12 comprised of visual panoramic information.

14. Panoramic information as in Claim 13 produced from within and from the exterior of a motor vehicle or trailer.

15. Triggering as in Claim 11 caused by substantial contact of a motor vehicle or trailer with another object.

16. Panoramic information as in Claim 14 produced as a single recordable image.

17. Triggering as in Claim 11 by a deliberate act of an occupant of a motor vehicle.

18. Triggering as in Claim 11 due to a substantial change in the velocity of a motor vehicle or trailer to which the system has been attached.

19. A recording system as in Claim 11 which monitors the general environment in which production of a product or substance occurs.

20. A continuous recording system of physical processes which retains information recorded before, during and after a triggering event.

21. A recorder as in Claim 20 for recording earthquake motion information.

22. A recorder as in Claim 20 for monitoring the production of a substance.

23. A substance as in Claim 22 which is a film, tape or sheet.

24. A substance as in Claim 22 which is a liquid.

25. A substance as in Claim 22 which is a solid, fungible, an aggregate or in suspension.

26. A processing system which converts stored data so as to substantially reproduce the visual images associated with an environment by mapping the information into multiple outputs each of which depicts a portion of said environment.

27. Multiple outputs as in Claim 26 which create a series of views which as a group provide a substantially panoramic view of an environment.

28. Multiple outputs as in Claim 26 comprised of outputs each having substantially equal visual arcs of viewing.

29. Arcs of viewing as in Claim 26 of substantially 45 degrees.

30. Arcs of viewing as in Claim 29 comprised of two sets of arcs each set of which comprises a substantially panoramic view.

31. Conversion as in Claim 26 by optical means and by a camera.

32. Conversion as in Claim 26 by digital signal processing means.

33. Conversion as in Claim 26 by a combination of optical means and digital signal processing means.

34. Stored data as in Claim 26 comprised of visual data mapped in an concentric band from an annular or conicoid mirror.

35. Visual data as in Claim 34 forming more than one concentric band from more than one annular or conicoid mirror.

Reference Numerals - Description

Numeral	Description
1.	Optical system, general reference number
2.	Fiber optic system
3.	Motion input device
4.	Process value input device
5.	Recording device
6.	Recording media
7.	Logic device
8.	Permanent storage device
9.	Automobile
10.	Truck cab
11.	Truck trailer
12.	Editing process
13.	Final footage
14.	Fisheye lens system
15.	Exterior visible light capture means
16.	Interior visible light capture means
17.	Reflecting mirror, flat
18.	Annular or conicoid mirror
19.	Camera
20.	Light Path
21.	Input data
22.	Processing/recording device
23.	Triggering event
24.	Computer
25.	Permanent storage
26.	Post production device
27.	Optics/DSP computer
28.	Output
29.	Sensor/trigger
30.	Optical/DSP preprocessing
31.	Inside mapping
32.	Interior video or film
33.	Outside mapping
34.	Exterior video or film
35.	Field of view, one sector, mapped output
36.	Direction of view
37.	Rotating mirror
38.	Button
39.	Manual force

40. Acceleration or deceleration sensor
41. Security system sensor
42. Air bag system sensor
43. Vehicle external body work
44. Vehicle frame
45. Deformation sensor
46. External damaging force
47. Radial direction of sweep of digital signal
48. Inner annular image
49. Outer annular image

S1 Save old data
S2 Save post trigger data
S3 Is permanent storage full?
S4 Quit
S5 Replace or renew permanent storage
S6 Reset trigger
S7 Signal from sensor/trigger

T_P	Pretrigger time (seconds)
T_F	Post trigger time (seconds)
N_E	Maximum Number of Possible Recordable Events

TABLE ONE

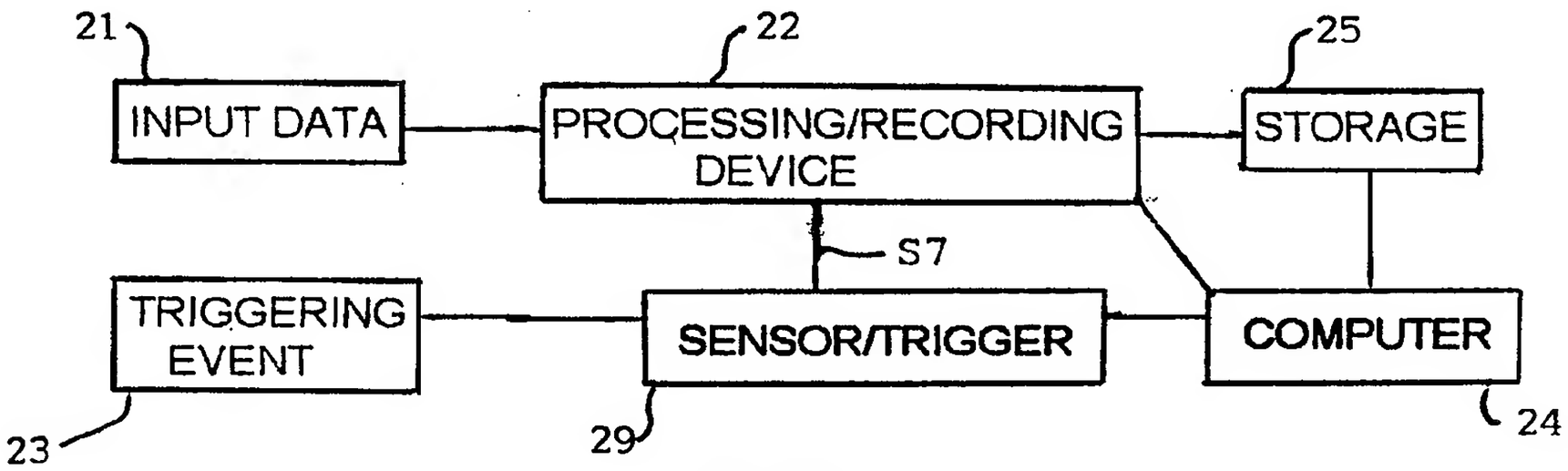

FIGURE 1.

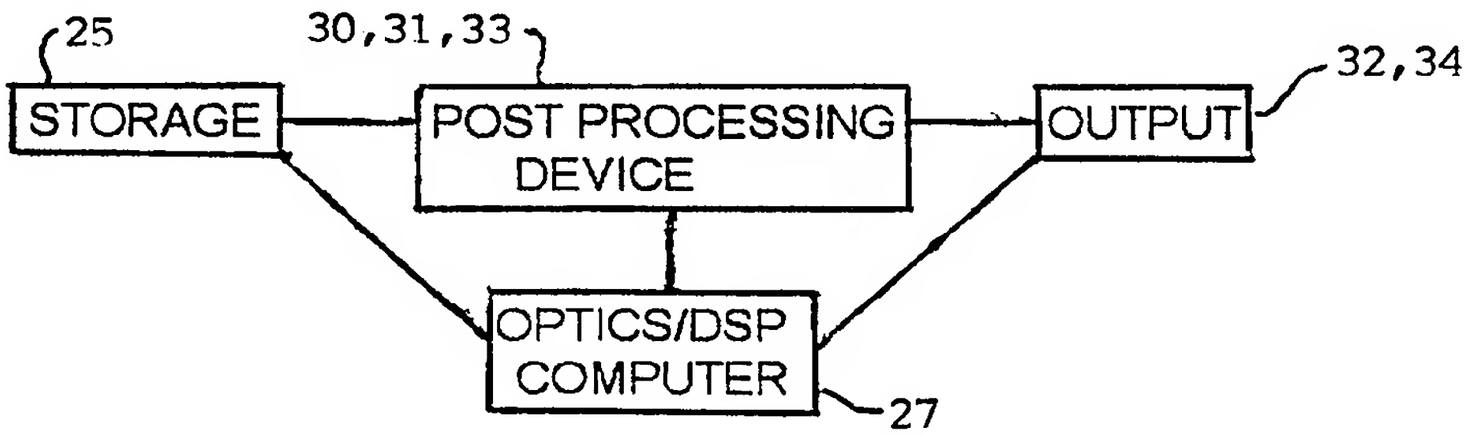

FIGURE 2.

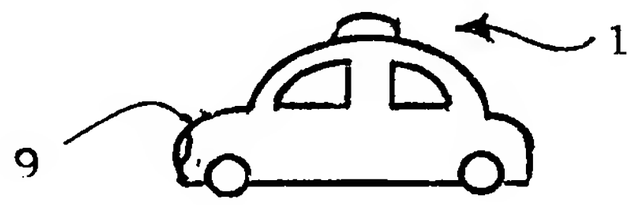

FIGURE 3.

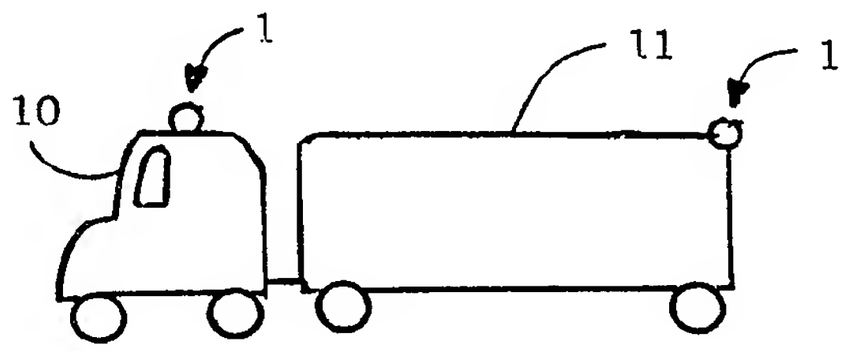

FIGURE 4.

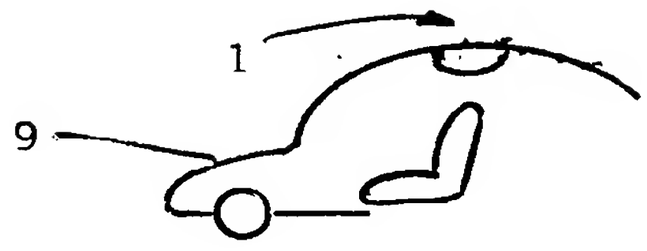

FIGURE 5.

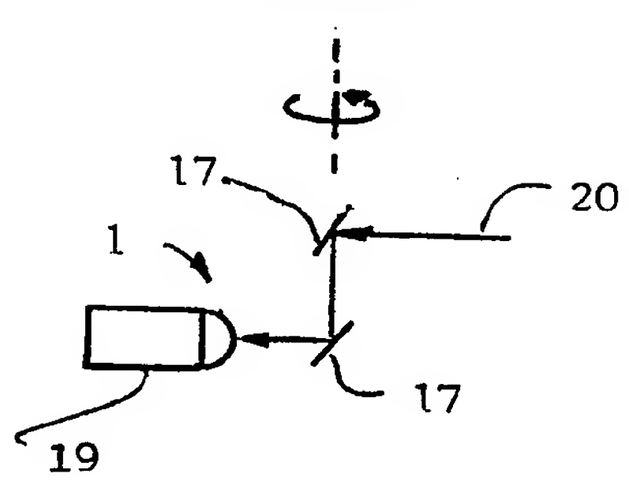

FIGURE 6.

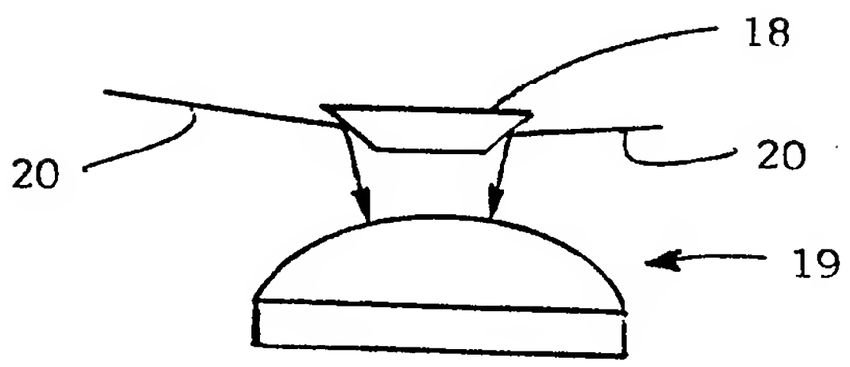

FIGURE 7

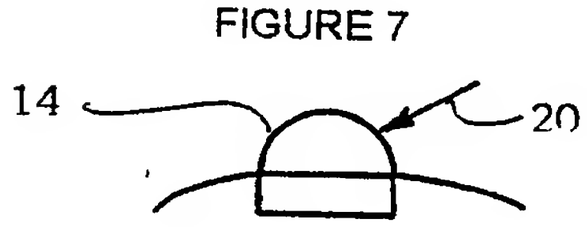

FIGURE 8

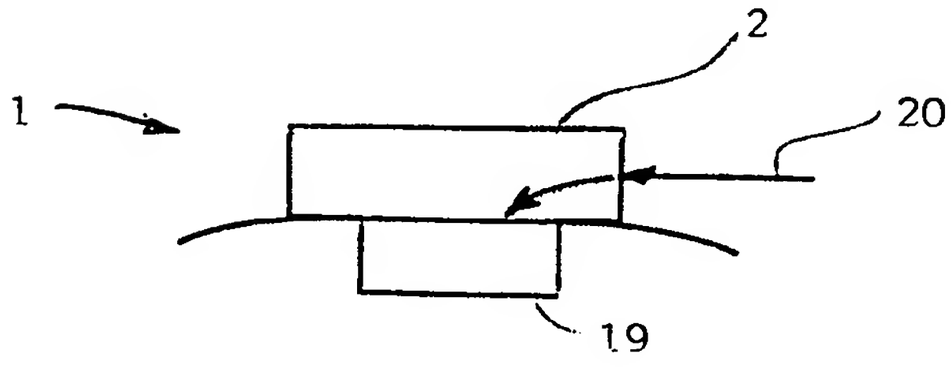

FIGURE 9

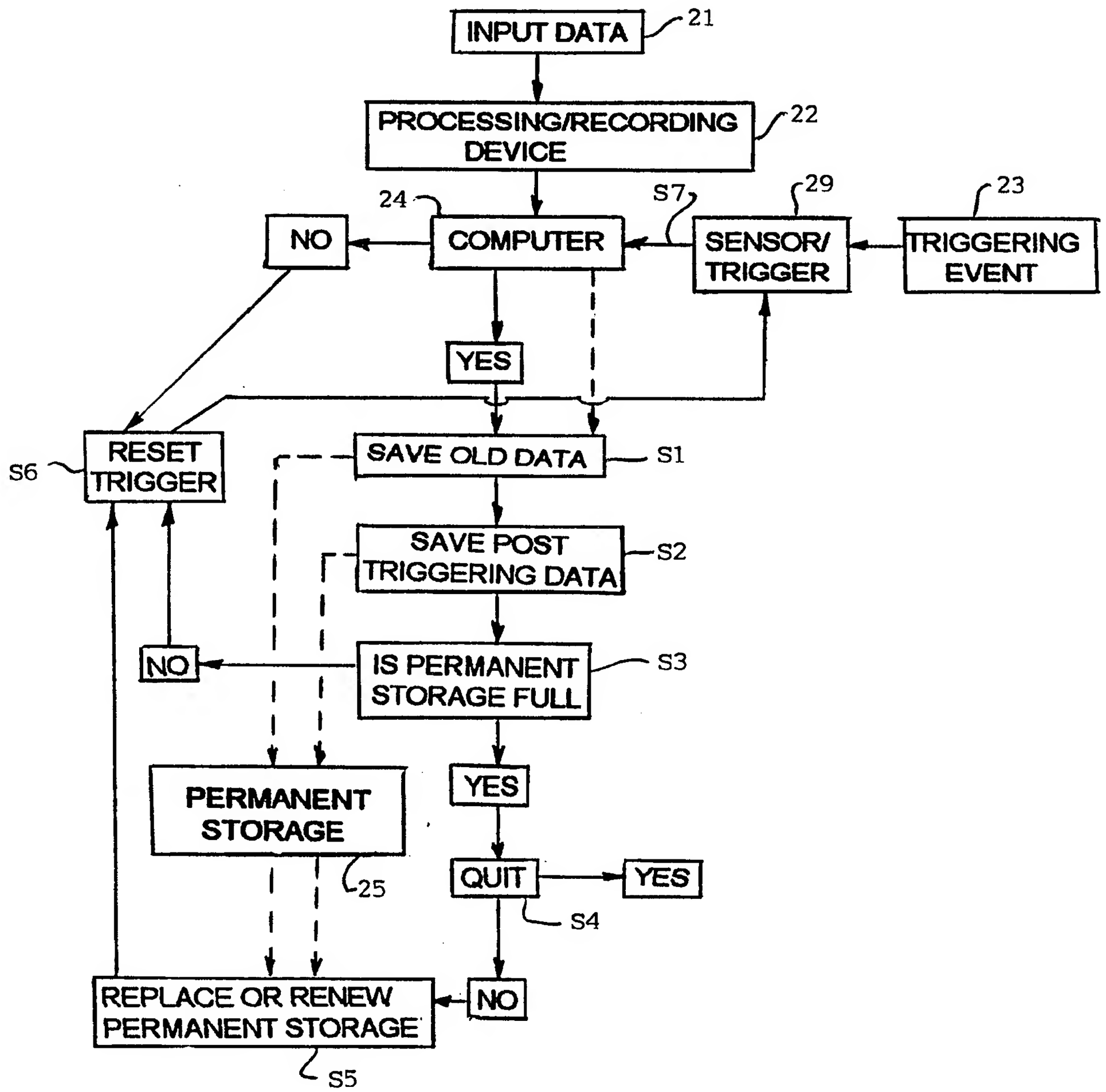
INPUT DATA
21
PROCESSING/RECORDING DEVICE
22
24
S7
29
23
NO
COMPUTER
SENSOR/ TRIGGER
TRIGGERING EVENT
YES
S6
RESET TRIGGER
SAVE OLD DATA
S1
SAVE POST TRIGGERING DATA
S2
NO
IS PERMANENT STORAGE FULL
S3
PERMANENT STORAGE
YES
25
QUIT
YES
S4
REPLACE OR RENEW PERMANENT STORAGE
NO
S5

FIGURE 10.

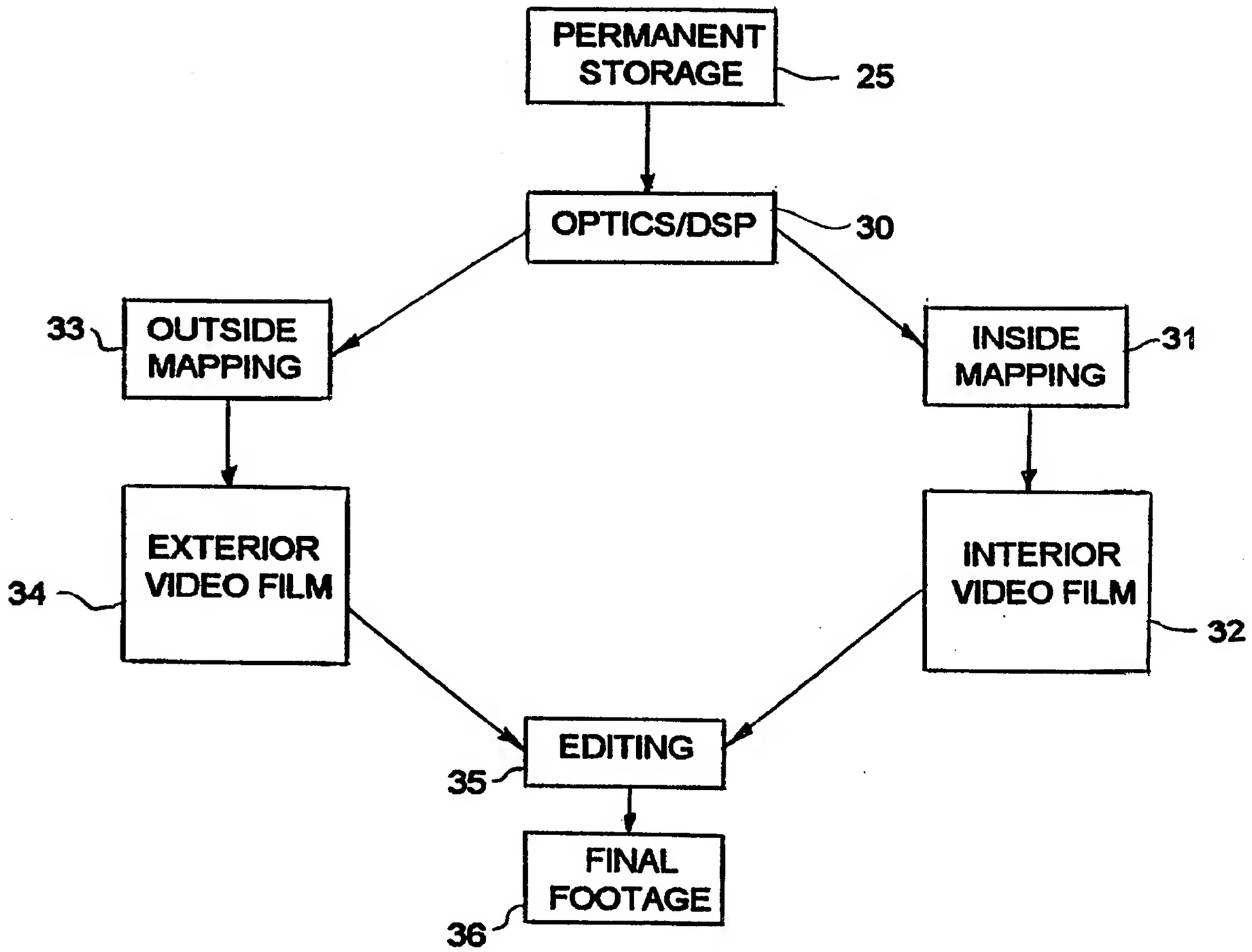
PERMANENT STORAGE
25
OPTICS/DSP
30
33
OUTSIDE MAPPING
INSIDE MAPPING
31
EXTERIOR VIDEO FILM
34
INTERIOR VIDEO FILM
32
EDITING
35
FINAL FOOTAGE
36

Figure 11.

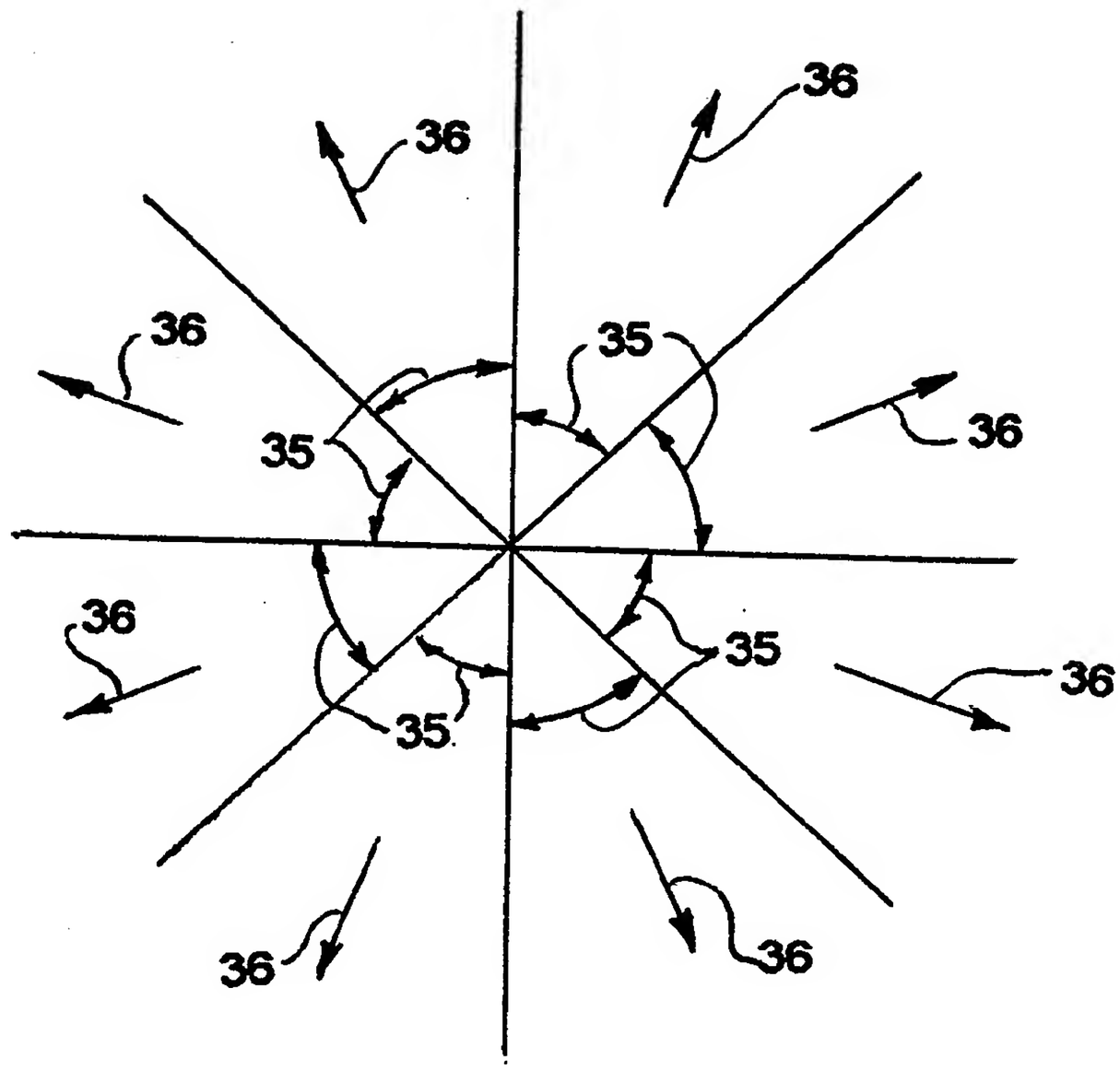

Figure 12.

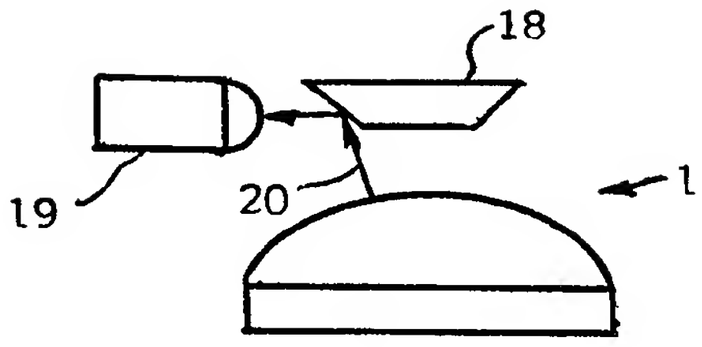

FIGURE 14.

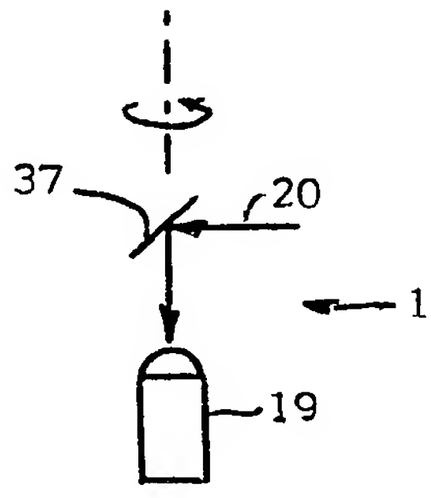

FIGURE 13.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/12129

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 07/00, 07/18
US CL :348/143,148,149,36,39

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 348/143,148,149,36,39,88,89,113,115,118

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS: panoramic, ommatidia disk, infrared.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,359,363 A (KUBAN ET AL) 25 OCTOBER 1994, COLUMN 9, LINES 28-68; COLUMN 10, LINES 1-50	1-6, 11 AND 26-33
X	US, 4,855,821 A (SWON ET AL) 08 AUGUST 1989, COLUMN 5, LINES 58-68; COLUMN 6, LINES 5-57.	11, 19-20, 22, 24-25.
X	US, 5,531,472 A (SEMCHENA ET AL) 02 JULY 1996, COLUMN 2, LINES 40-68; COLUMN 3, LINES 1-24; COLUMN 4, LINES 65-68; COLUMN 5, LINES 1-44.	11, 18
X	US, 5,305,099 A (MORCOS) 19 APRIL 1994, COLUMN 2, LINES 53-68; COLUMN 3, LINES 18-51.	20, 23

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 SEPTEMBER 1997	07 NOV 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer TOMMY P. CHIN Telephone No. (703) 305-4700

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/12129

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, 5,499,049 A (ESFANDIARI et al) 12 March 1996, column 4, lines 36-46, 53-68; column 5, lines 1-36.	20-21
Y	US, 4,913,458 A (HAMILTON) 03 April 1990, column 5, lines 35-61.	10
Y	US, 5,563,650 A (POELSTRA) 08 October 1996, column 3, lines 38-68; column 4, lines 1-30.	9, 12-17.
Y	US, 5,097,325 A (DILL) 17 March 1992, column 2, lines 46-68.	7-8, 34-35.
A	US, 5,355,118 (FUKUHARA) 11 October 1994.	18
A	US, 4,670,648 A (HALL et al) 02 June 1987.	6-9,13-16, 26-35.
A, P	US, 5,612,533 A (JUDD et al) 18 March 1997.	6-9, 13-16, 26-35